# Section 3 Promotion of Life Innovations

Life science clarifies the complicated and sophisticated mechanisms of life phenomena taking place every life form. For instance, it makes dramatic progress in medicine and finds answers to various problems involving food and environment. The output of life science thus makes a large contribution to enhancement of living standards of the citizens and development of the national economy.

For the progress of life innovation, Japan's 4th Basic Plan has presented below (1) to (4) critical issues to achieve, and the government and ministries such as MEXT are now advancing the below-described efforts.

## 1 Promotion of Measures to Solve Critical Issues on Life Innovations

### (1) Development of Innovative Prevention Methods

#### 1) Promotion of the Construction of Next-generation Medical Care System

While closely coordinating with the construction project of infrastructure for regional medical information sharing promoted under the support of the Ministry of Internal Affairs and Communications (MIC) and the Ministry of Health, Labour and Welfare (MHLW), MEXT currently helps reconstruct medical care system in disaster-hit areas by promoting the "Tohoku Medical Mega-Bank Project." In doing so, the Ministry aims to realize next-generation medical care such as individualized medicine in the disaster-hit region as quickly as possible.

#### 2) Efforts to Realize Personalized Medicine

To realize a system that provides individually-optimized medical care (personalized medicine), MEXT carries out the "Project on the Implementation of Personalized Medicine (2nd phase)." In this project, MEXT, using the BioBank that manages blood samples and clinical information collected from patients, focuses on efforts to understand the relationship between the disorders that have an especially large impact on people's health and the genetic information. RIKEN also pursues studies to unravel causes of human diseases, etc., in conjunction with MEXT's project.

#### 3) Efforts to Understand Environmental Risks to Children

It has recently been pointed out that the possibility of environmental risks to children has been increasing.

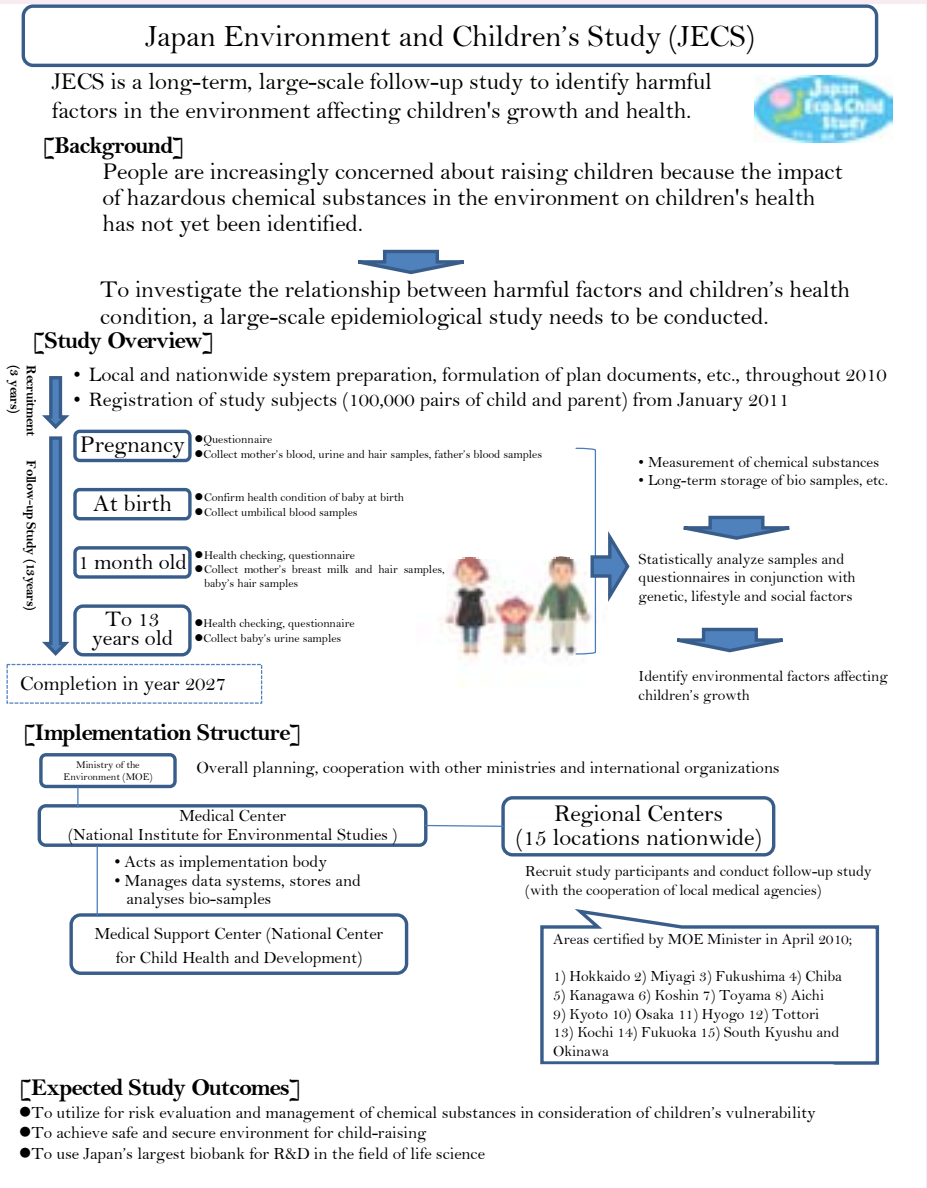
In order to determine the effects of environmental chemicals on children's health, the Ministry of the Environment (MOE) commenced the "Japan Environment and Children's Study (JECS")" in 2010, a large-scale and long-term birth cohort study involving 100,000 groups of parents and children (Figure 2-2-9). The purpose of this study is to harvest, preserve and analyze the biological samples such as blood, umbilical cord blood, and breast milk of the participants (pregnant women), and conduct a follow-up study on the children until they reach the age of 13 through methods such as questionnaire.

In this study, the National Institute for Environmental Studies analyzes the collected data and bio samples, and summarizes the results of whole study as central facility. Likewise, the National Center for Child Health and Development provides medical support as a medical support center, and unit centers established at facilities such as universities in publicly-selected 15 regions across the country recruit participants and conduct a follow-up study on the children to be born in the future. During 2010, the

commencement year for JECS, universities and medical institutes throughout Japan made efforts to consolidate the implementation structure for the study, and are currently recruiting participants for the next 3 years from the end of January 2011.

Based on the knowledge gained through the study, MOE intends to achieve a healthy life for children as well as a safe and secure environment for child-raising through various measures such as strengthening the risk management of chemical agents. In the meantime, 100,000 sets of biological samples and data collected are expected to be used to ensure international competitiveness of Japan's fundamental research as common basis for medical- and health-related research.

Figure 2-2-9/ Japan Environment and Children's Study (JECS)




Source: Created by Ministry of the Environment

4) Efforts to Overcome Emerging and Re-emerging Infectious Disease

Lately, newly discovered infectious diseases (emerging infectious disease) and those thought to have been contained but have raged once again (re-emerging infectious disease) are drawing worldwide attention. These diseases still present many questions to be shed further light on, for instance, their pathogen (i.e. disease-causing agents), route of infection, infectious capacity, and pathogenic mechanism.

To tackle this problem, MEXT has launched the "Japan Initiative for Global Research Network on Infectious Diseases." With the use of a network of 13 collaborative research centers in 8 countries, the Ministry engages in such activities as promoting R&D for medical measures against infections, collecting basic knowledge and cultivating human resources in this field.

MHLW works on the issues such as the development of appropriate diagnostic, therapeutic and preventive methods against infectious diseases, and moves forward with studies leading to the necessary administrative responses. With particular focus on vaccination, one of the efficient preventive measures against infectious diseases, the Ministry conducts research that assesses vaccine's safety, medical economic efficiency, etc., and then incorporates the findings into vaccination-related administrations. Furthermore, in the fields relevant to a new strain of influenza, MHLW, through research that accelerates the development of cell culture-based and intranasal vaccine, aims to achieve simpler and more effective vaccines, and quickly supply them during an outbreak of a strain of new influenza.

5) Efforts to Overcome Psychological and Neurological Disorders

Brain science research is expected to produce results that lead to the improvement of life quality and medicine, as well as creation of new technologies and industries.

Because it is important to strategically advance Japan's brain science research and give back the achievements to society, MEXT compiled an initial report regarding the basic concept and promotion policy of future brain science research from a long-term standpoint at the Council for Science and Technology in June 2009. In light of this report, MEXT has implemented the "Strategic Research Program for Brain Sciences (SPRS)" for the realization of brain sciences that contribute to society. Under the program, MEXT promotes a number of studies involving exploring brain's biological indicator (a.k.a. social brain marker) related to human social behaviors, studying the relations between genetic factors and environmental stress, understanding the pathogenic mechanism of psychological and neurological disorders, and overall aims to utilize the research results for early diagnosis, treatment and prevention.

Brain science research pertaining to molecular structure, neuron cells, and neural circuits are also being pursued under the Strategic Basic Research Programs by RIKEN and JST.

(2) Development of New Early Diagnostic Methods

(Promotion of Molecular Imaging Research and Image Diagnostic Technology Development)

In order to secure people's health, it is critical to develop diagnostic methods that enable early detection of disorders. The government has therefore been working on development of early diagnostic technology with high-accuracy.

MEXT has launched the "Japan Advanced Molecular Imaging Program (J-AMP)" aiming for early application of molecular imaging technologies that visualize living organism's intravital molecular amount and activities to medical care. Joint R&D projects for the demonstration of molecular technologies are

currently conducted under collaboration between the "Research Base for Exploring New Candidate Drugs"/"Research Base for Positron Emission Tomography (PET) Diagnosis" and universities/hospitals.

Aiming for the realization of early detection of disorders, MHLW pushes forward the development of diagnostic imaging equipment and molecular imaging technology using other technologies including nanotechnology. Concurrently, the Ministry advances studies on exploring such substances as protein needed for toxicity and effectiveness assessment on candidate compounds for medical drug development. Furthermore, focusing on the diseases such as refractory cancer, MHLW also promotes R&D toward practical application of innovative diagnostic imaging technology using new biological indicator specific to cancer.

Meanwhile, the Ministry of Economy, Trade and Industry (METI) has launched the "Comprehensive R&D of an Early Stage Diagnosis Method and Instruments to Treat Cancer" to develop a highly-sensitive and highly-accurate diagnostic imaging system that enables providing information on cancer's form, position and malignant grade necessary for making precise medical decisions. Furthermore, in the transitional projects for universities with promising basic research achievements expected to fit for practical use in medical care, METI has worked to establish a technology that provides an accurate and objective evaluation on the progression from mild cognitive impairment to Alzheimer's disease, for the development of Alzheimer's disease diagnosis and basic medical drugs against Alzheimer's.



(3) Realization of Safe and Highly-Effective Treatment

1) Promotion of Research on Cell Generation, Differentiation and Regeneration

Research in the realm of cell generation, differentiation and regeneration aims to unravel biological mechanisms such as how a single cell differentiates into various tissues/organs, and forms and maintains an individual organism. These studies are to be the basis for regenerative medicine, and have recently led to the rapid advancement of research on stem-cells including iPS cells and establishment of technology to create embryonic stem (ES) cells.

Based on the "Revised Total Strategy for Acceleration of Research on iPS Cells (i.e. Induced Pluripotent Stem Cells) (decision by Minister of MEXT, January 2009)," MEXT has been preparing bases for comprehensive research on stem cells including iPS cells as outlined in the "Project for Realization of Regenerative Medicine (2nd Phase)." In order to steadily accomplish the targets set in the "Road Map on iPS Cell Research (MEXT, June 2009)," the Ministry also promotes research toward the clinical application of basic research achievements. In addition, MEXT carries out basic research at institutes such as RIKEN and under the Strategic Basic Research Programs by JST. Along with the government and other related ministries, MEXT has also been making concerted efforts to improve iPS cell research system, secure funds necessary for research, protect and manage intellectual property (IP). According to the "Highway Program for Realization of Regenerative Medicine" kicked off in 2011, MEXT, in cooperation with relevant ministries, has been working to achieve early establishment of regenerative medicine while conducting coherent stem cell R&D ranging from pre-clinical to clinical study based on the basic research results.

Likewise, MHLW aims to speed up and streamline the drug development process. For this purpose, the Ministry promotes basic technology research that contributes to exploration and selection of candidate compounds for drug development, such as creating new disease-model animals based on the needs of drug development, differentiating and inducing cells including human iPS cells to target human cells. MHLW

also seeks to establish a platform for safe and effective regenerative medical technology through integrated promotion of research on critical issues for early clinical application of the technology using human stem cells including human iPS cells, such as tumorigenic potential and rejection reaction.

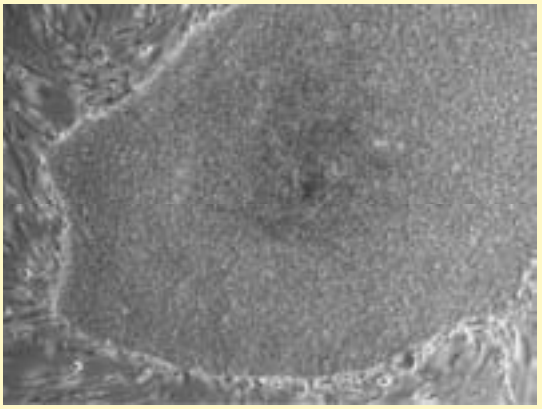
METI, based on the "Research and Development of Next-generation Regenerative Technology," aims to develop a regenerative device that stimulates internal tissue regeneration and carries out research to establish a technology to evaluate the effectiveness and safety of regenerated tissues. The Ministry also conducts R&D on the system that assesses the safety of drugs using iPS cells in order to streamline drug development process. In addition, since 2011, METI has been pursuing development of basic technology that stably supplies a large volume of high quality stem cells, necessary for the practical application of regenerative medicine that requires stem cells including iPS cells.

Column 2-1

### Present Status of Stem-Cell (including iPS cell) Research and Its Recent Achievements

Stem-cell (including iPS cells (Inducted Pluripotent Stem Cell)) research has two general aspects; application to regenerative medicine and disease-model cells. In terms of regenerative medicine, since the iPS cells issue in Japan falls under the guidelines formulated by MHLW for clinical studies using human stem cells, the Ministry is currently hastening the pace of preparation for the implementation of earliest-possible (preferably within the next 5 years), clinical study for retinopathy, spinal cord injury, Parkinson's disease, cardiac infraction and corneal disorders. On the other hand, disease-model research has been a highly competitive and worldwide realm to study, in terms of identifying the underlying cause of mental disorders, neurological refractory diseases, lifestyle-related diseases and irregular heartbeat, and also applying to discovery of new drugs.

As a result of relevant ministries' efforts to pursue stem-cell (including iPS cell) research since Prof. Shinya Yamanaka of Kyoto University established human iPS cells in November 2007, various breakthrough results have been achieved. In June 2011, for instance, the research group led by Prof. Yamanaka established the iPS cell induction method far more effective than conventional methods. Before, iPS cells were created through introduction of the 4 transcription factors[1] (Oct3/4, Sox2, Klf4, c-Myc) using retroviral vector[2] into fibroblast cells, but it was concerned that c-Myc, a proto-oncogene, could trigger the occurrence of tumors. Furthermore, because the introduction without c-Myc often failed to properly create iPS cells, the development of methods to effectively induce safe iPS cells was also expected. Hence, Prof. Yamanaka and his research group introduced Glis1, a transcription factor intensively expressed in egg cells, along with 3 other factors (Oct3/4, Sox2, Klf4) using retroviral vector into mouse or human fibroblasts, and then iPS cell's creation efficiency significantly increased in both cases. This research outcome is expected to make an enormous contribution to the establishment of iPS cell creation method available for clinical applications.



Succeeded in highly efficient production of an iPS cell.
Source: Kyoto University

Regenerative medicine research deals with highly versatile technologies including iPS cell technology so that they have been more exposed to globally fierce competition than ever. Therefore, in recognition of the importance of regenerative medicine studies, MEXT and other ministries including MHLW and METI are currently providing intensive support for such research. In addition, as reported in July 2011, Kyoto University's request of the patent regarding iPS cells was unprecedentedly approved in Europe, and Japan is thus developing a competitive advantage in this field. Nevertheless, the future of Japan's regenerative medicine research depends on the efforts that will be made for the next few years. To this end, the Japanese government is determined to continue its active efforts for the promotion the research.

### 2) Promotion of Innovative Cancer Research

According to statistics, one out of two contracts cancer, and one out of three dies from it in Japan

[1] A protein material which functions when genetic information are decoded.
[2] Retroviral vector serves as a "carrier" when introducing target gene to animal cells.

(360,000 in 2011). Just as before, cancer still presents a grave threat to our lives and health today. To cope with this threat, the government of Japan, in accordance with the "Comprehensive 10-year Strategy for Cancer Control (decision by Minister of MEXT and MHLW, July 25, 2003)," "Cancer Control Act (Act No. 98 of 2006)" and "Basic Plan to Promote Cancer Control Programs (decision by Cabinet Council, June 15, 2007), has been developing new preventive, diagnostic and treatment methods utilizing research achievements and pursuing to understand the true nature of cancer.

Based on the "Present Status and Future Directions of Cancer Research (released by Working Group for Cancer Research Strategies, July 2010)," MEXT, in cooperation with other agencies including MHLW and METI, has implemented the "Project for Development of Innovative Research on Cancer Therapeutics (P-DIRECT)" since 2011, which promotes strategic R&D of the basic compounds (seeds) that contribute to development of next-generation innovative diagnostic techniques and new therapeutic agents incorporating basic research results.

MHLW focuses on development of innovative treatment methods that inhibit or kill cancer stem cells specifically for such conditions as refractory cancer, while also conducting the pervious strategic cancer research. With the recent rapid development of cancer vaccine therapy across the world as the 4th therapeutic method next to surgery, radiotherapy and chemotherapy, MHLW has been promoting high-quality and physician-centered clinical trials in order to develop made-in-Japan cancer vaccines for practical use by leveraging the abundant research findings in the country. In addition, the Ministry also pursues palliative care-related research to establish more efficient therapeutic and assessment methods for cancer-related pain, advanced communication methods while battling cancer, and assessment methods for the quality of palliative care. Through the research MHLW endeavors to alleviate social distresses associated with physical pain including cancer-related pain, emotional and psychological pain such as depression and anxiety, unemployment and financial problems for cancer patients as well as their families.

Under the "Comprehensive R&D of an Early Stage Diagnosis Method and Instruments to Treat Cancer," METI works to develop a highly-accurate diagnostic imaging system that provides the information on cancer's form, position, and malignant grade necessary for making precise medical decisions, a diagnosis-treatment-combined endoscopic surgery supporting system that enables a reliable treatment with minimal resection, and an X-ray therapy device performing pinpoint-treatment on micro cancer cells.

### 3) Promotion of Protein Structure and Function Analysis

Protein is a fundamental molecule constituting life. Thus, the analysis of its structure and functions is essential for the future progress of medicine and pharmaceutical science, and its industrial applications in such fields as food and environment.

Despite difficulties originating in the current level of technology, MEXT, with maximum use of the research infrastructures that have been developed for protein analysis, has implemented the "Targeted Proteins Research Program" to analyze the structure and functions of the targeted proteins indispensable for academic research and industrial development. Subsidizing a part of the program in 2011, MEXT continues to promote development of infrastructures for protein research under the program currently known as the "Platform for Drug Discovery, Informatics, and Structural Life Science."

For the acceleration of new drug discovery based on genetic information, METI focuses on R&D of basic technologies, for instance, technology that improves the efficiency of drug development through

simulations or provides highly accurate analysis of acquired genomic modification, with use of structural information of membrane protein that plays a critical role in a living organism.

4) Promotion of Genomic Research

With the completion of sequence decoding of human genome as well as the results of subsequent genomic function analysis, MEXT launched the "Research Program of Innovative Cell Biology by Innovative Technology (Cell Innovation)" in 2009 to decode a life program of cancer cells, etc., using innovative analysis technologies including next generation sequencing technology.

5) Promotion of R&D on Radiotherapy Device

The National Institute of Radiological Sciences (NIRS) promotes charged particle radiotherapy research, a promising breakthrough therapy for refractory cancer. Furthermore, based on the results of NIRS-initiated R&D, Gunma University has established a compact-sized heavy ion irradiation facility and is currently conducting radiotherapy.

6) Promotion of Dynamic Biological Systems Science Research

Life is composed of complex systems in which multiple biological factors are intertwined both spatially and temporally. By promoting "Dynamic Biological Systems Science" to understand and control these complicated biological systems, therefore, it is expected to make a significant contribution to the creation of revolutionary technologies such as regenerative medicine and pathological prediction.

MEXT carefully studied the promotion policies and finalized the "Future Prospect of the Promotion of Dynamic Biological Systems Science (July 19, 2011)" at the Dynamic Biological Systems Science Strategic Working Group of Life Sciences Committee, the Research Plan and Assessment Subcommittee under the Council for Science and Technology. RIKEN and Osaka University have already taken the lead in measuring, calculating and modeling life phenomena, and developing and performing advance research on cutting-edge technology for reconstitution of cell functions. In the same manner, JST has also undertaken a study aiming for the creation of basic technologies according to JST Strategic Basic Research Programs.

7) Other Efforts for Safe and Effective Treatment

With regard to efforts aiming for safe and effective treatment, RIKEN conducts basic research on immunity and allergy diseases. With the joint research agreement between Riken and Sagamihara National Hospital of National Hospital Organization, RIKEN endeavors to advance effective research in this field, based on the collaboration between basic and clinical studies.

MHLW currently boosts the development of "Companion Diagnostics" for predicting the effects of a drug or the risks of side effect, in addition to the development of research on drug delivery systems, etc. In order to provide patients with safer and more secure medical treatment, the Ministry is also working to build innovative medical devices with non-invasive/minimal invasive features using technologies such as nanotechnology.

### (4) Improvement of Quality of Life (QOL) for the Elderly, Persons with Disabilities and Patients (Promotion of Medical and Welfare Technology Development)

In Japan, birthrate has been declining and the number of aging people has been increasing at unprecedented speed. Under these circumstances, appropriate responses to the problems related to social welfare and improvement of quality of people's lives are required.

On this issue, MIC, MEXT and MHLW are working to develop Brain-Machine Interface (BMI) that reads the information in the brain low- or non-invasively and enables to heal, recover, and complement human body functions. With the development of BMI, the ministries aim to support people's daily lives and apply the technology in the clinical environment.

MIC also seeks to apply BMI in the fields of health care and livelihood support. The Ministry is currently conducting R&D of network robot technology that performs delicate movements possible by collecting information and analyzing situation through networks.

In order for persons with disabilities to be independent and participate in social activities, MHLW has been conducting the "Project for Development and Promotion of Equipment to Support Independence of Persons with Disabilities" since 2010, which develops user-friendly supporting equipments that adequately reflect the needs of persons with disabilities.

In the meantime, METI promotes supporting projects for the business operators dealing with R&D of welfare-related equipment. In such fields as nursing care and transportation support for persons with disabilities, METI also makes efforts to develop interpersonal safety technology necessary to operate a robot that offers direct daily life support, collects and analyzes the data for establishing the methods for robot's safety verification, and internationally standardize the safety criteria for the robot.

## 2 Systemic Reform for the Promotion of Life Innovations

To successfully promote life innovations, it is necessary, along with the promotion of the measures for other critical issues, to prepare a system that promptly puts the results of these measures into practical use of medical drugs or devices. Thus, relevant ministries including MEXT promote the development of biological resources and databases that are the foundation for life science research, in addition to the improvement of bases for supporting R&D of medical drugs and equipment. Also, it is equally important to make such efforts as appropriately conducting delicate experiments such as animal experiments, dealing with bioethical issues, and ensuring safety in performing activities related to life sciences.

### (Improvement of System to Promote Medical R&D for Practical Application)

Upon the "Health Power Strategy through Life Innovation" being positioned as one of the national strategies in the "New Growth Strategy (decision by Cabinet Council, June 18, 2010)," the Cabinet Office decided to set up the "Medical Innovation Council" headed by the Chief Cabinet Secretary at the "Council on the Realization of the New Growth Strategy" held in November 2010. In this Medical Innovation Council, discussions on future strategies which Japan needs to implement in order to quickly put cutting-edge medical technologies into practical use were held, and as a result, the Office for Promotion of Medical Innovation in the Cabinet Office was established on January 7, 2011, as national command center for promoting medical innovations. In addition to creation of this new office, the "Basic Policy on Promoting of Medical Innovation" was finalized, and specific measures regarding how to proceed with

medical innovations such as development of new drugs and medical devices as well as efforts to achieve regenerative and personalized medicine were presented in the Council.

(Promotion to Prepare Supporting Infrastructures for Drug- Discovery and Medical Technology)

For producing technology seeds leading to creation of new drugs as well as development of new medical equipment, and accelerating the process toward practical applications, infrastructures that support such technologies need to be prepared under cooperation between the public and private sectors.

To this end, MEXT currently promotes the project of "Platform for Drug Design, Discovery and Development," which prepares and operates bases to encourage private companies and universities to widely share cutting-edge equipment for measurements or analysis.

Library of 210,000 Compounds Prepared at Open Innovation Center for Drug Discovery, University of Tokyo
Source: University of Tokyo

(Promotion to Prepare Supporting Infrastructures for Transitional Research and Early/Exploratory Clinical Trial)

While working in collaboration with MHLW, METI and other agencies at councils such as the Health Research Promotion Council[1], MEXT has been advancing the "Coordination, Support and Training Program for Transitional Research" to prepare bases that support transitional research for universities or other institutes that have produced promising results of basic research expected to fit for practical use in medicine. The program became governmentally-subsidized in 2011 specifically to achieve self-sustaining research activities at each base, and currently endeavors to further activate transitional research by encouraging other parties other than the participants into the program.

Aiming to develop innovative, made-in-Japan medical drugs and devices, MHLW promotes the "Project of Early Exploratory Clinical Trial Bases for Specific Research Areas" to prepare world's first bases that enable clinical trials such as administrating new drugs or using new medical devices on human body. The subject bases for this program are such institutions as advanced treatment hospitals, national centers for advanced and specialized medical care.

Meanwhile, in order to put the prominent technology seeds developed by academic institutes and

[1] For the promotion of "Health Research," the Health Research Promotion Council has been set up for promoting all transitional and clinical research implemented by each relevant ministry under one primary strategy in a unified manner. Chaired by the Minister of State.

venture companies into practical use, the Pharmaceuticals and Medical Devices Agency (PMDA) started the pharmaceutical affairs consultation on R&D strategy in July 2011.

In cooperation with MHLW, METI implemented the "Program to Formulate Guidelines designed to Promote Development and Commercialization of Medical Equipment," and currently advances the development of medical devices with the expectation of future practical application by specifying such items as an endpoint for technological and biological stability of a device.

(Development of Biological Resources (hereinafter referred to as "BioResources"))

BioResources are considered important not only from the perspective of biological genetic resources preservation but also from that of discovery of new realms for scientific research. Therefore, it is necessary to deal with their development, collection, preservation and provision from a national point of view.

For the purpose of preparing a system that systematically collects, preserves and provides the bioresources deemed necessary to be strategically developed by the government out of ones such as research animals and plants that constitute the basis of life science research, MEXT has implemented the "National BioResource Project." In addition, the Ministry also actively engages in developing biogenetic resources across Asia. For instance, MEXT has been pursuing to conclude bilateral agreements with Asian nations that have already ratified the Convention of Biological Diversity, and formulate a multilateral cooperative framework (Asian Consortium) aiming for the preservation and sustainable utilization of microbiological resources.

*Arabidopsis* used as a Model Plant in Plant Science
Source: Institute of Physical and Chemical Research (RIKEN)

(Promotion of Life Science Database Integration)

For developing means to effectively utilize the databases of, for instance, DNA sequence, three-dimensional protein structure and gene expression generated in large quantity due to the recent progress of life science research, it is important to improve integrated databases of life information, and promote bioinformatics, an integrated science field of life science and information technology.

In May 2009, at the Integrated Database Task Force Committee placed in Life Science Project Team under the Council for Science and Technology Policy (CSTP), a report concerning how the "centers" should constantly answer and provide functions that users ask for was compiled. The report summarized the desirable center's functions, in particular, input new information into databases, maintain and control

databases, etc., for the promotion of effective data utilization and prevention of valuable data/databases collected or compiled under the relevant ministries' individual projects from spreading out. In light of this report, MEXT's "Integrated Database Project" and JST's "Institute for Bioinformatics Research and Development (BIRD)" were integrated, and the "Life Science Database Integrated Project" were initiated in the newly-installed National Bioscience Database Center (NBDC) at JST in 2011. Furthermore, in December 2011, MEXT, MHLW, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and METI together launched a portal website[1] introducing policies and achievements of integrated database regarding the life science projects that these ministries engage in.

(Issues in Developing System for Life Science Research)

1) Efforts for Proper Conduct of Animal Experimentation

In June 2005, the Act on Welfare and Management of Animals (Animal Protection Control Law) was revised by legislation introduced by Diet members, and the principles of 3Rs (use of Replacement technique, Reduction of laboratory animals, and Refinement of pain associated with experiment) upon conducting animal experimentations were specified.

This Act clearly distinguished laboratory animal from animal experiments, and assigned the Minister of MOE to set laboratory animal-related standards. Later on April 28, 2006, the "Standards relating to the Care and Management of Laboratory Animals and Relief of Pain (the Guidelines for Raising and Keeping Laboratory Animals)" was officially announced. Formulating integrated basic guidelines for research institutions that have jurisdiction over laboratory animals, MEXT, MHLW and MAFF have been facilitating an appropriate conduct of animal experimentations according to these guidelines.

2) Efforts for Ethical Issues

While recent rapid progress of life science is considered useful for society, it also poses possibility that new ethical problems regarding human dignity or human rights arise. To deal with this issue, the relevant ministries implement necessary measures and regulations.

Human ES (i.e. embryonic stem) cell research, for instance, indicates great potential for progress in medicine and biology, but it also presents such ethical problems as human ES cells being developed from actual human embryos. Based on the "Guidelines on the Derivation and Distribution of Human Embryonic Stem Cells (Ministerial Notification No. 86 of MEXT, 2010)" and "Guidelines on the Utilization of Human Embryonic Stem Cells (Ministerial Notification No. 87 of MEXT, 2010)," therefore, the use, derivation and distribution of human ES cells for basic research must be ensured its proper conduct. Likewise, research using technologies such as cloning technology must also be ensured its proper conduct under the "Act on Regulation of Human Cloning Techniques (Act No.146 of 2000)."

As for human genome and gene analysis research, MEXT, MHLW and METI has been considering revising the "Ethical Guidelines for Human Genome/Gene Analysis Research" at a joint committee held since April 2011, in light of latest research trends, development of analysis technology.

[1] http://integbio.jp/ja/

3) Efforts for Ensuring Safety in Life Science

Genetic modification is a technology creating new genetic combinations that do not exist in nature, and is applied to a wide range of fields such as drug manufacturing and agricultural crop improvement, including basic biological research. In terms of use of living modified organisms, regulations necessary to prevent adverse effect on biological diversity have been implemented based on the "Act concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Act No.97 of 2003)." Proper conduct of clinical research for the establishment of gene therapy has also been promoted under the "Guidelines for Gene Therapy and Clinical Research (MEXT 2004, Ministerial Notification No. 2 of MHLW)."

Table 2-2-10/ Major Projects/Programs for Promotion of Life Innovations (2011)

| Ministry or Agency | Implementing Agency | Project/Program |
|---|---|---|
| Ministry of Internal Affairs and Communications (MIC) | Ministry | Novel and Innovative R&D Making Use of Brain Structures |
| | | R&D on Service Robot Technology |
| | National Institute of Information and Communications Technology (NICT) | Research and Development of Universal Communication Basic Technology |
| | | Research and Development Future Information and Communications Basic Technology |
| Ministry of Education, Culture, Sports, Science and Technology (MEXT) | Ministry | Project for Realization of Regenerative Medicine |
| | | Project for Development of Innovative Research on Cancer Therapeutics |
| | | Strategic Research Program for Brain Sciences |
| | | Coordination, Support and Training Program for Transitional Research |
| | | Project of Platform for Drug Design, Discovery and Development |
| | | National BioResource Project |
| | | Tohoku Medical Megabank Project |
| | | Cell Innovation Program (Targeted Proteins Research Program and Innovative Cell Biology by Innovative Technology) |
| | | Project on the Implementation of Personalized Medicine |
| | | Japan Advanced Molecular Imaging Program (J-AMP) |
| | | Japan Initiative for Global Research Network on Infectious Diseases |
| | Institute of Physical and Chemical Research (RIKEN) | Comprehensive Research Project on Brain Science |
| | | Plant Science Research Project (RIKEN Plant) |
| | | Immunity and Allergy Science Integrated Research Project |
| | | Genomic Medicine Research Project (RIKEN Genome) |
| | | Generative and Regenerative Science Integrated Research Project |
| | | Molecular Imaging Research Project |
| | | Bio-Resources Project (RIKEN Bio-Resources) |
| | | Life Sciences Research Centers Project (RIKEN Life Sciences Platform) |
| | | RIKEN Computational and Quantitative Life Science |
| | Japan Science and Technology Agency (JST) | Life Sciences Database Integrated Project |
| | National Institute of Radiological Sciences (NIRS) | Research in Heavy-ion Cancer Therapy |
| | | Molecular Imaging Research |
| Ministry of Health, Labour and Welfare (MHLW) | Ministry | Research Project on Emerging and Re-Emerging Infectious Diseases |

| | | |
|---|---|---|
| | Ministry & Pharmaceutical and Medical Devices Agency (PMDA) | Project to Promote Pharmaceutical Affairs Consultation on R&D Strategy |
| Ministry of Agriculture, Forestry and Fisheries (MAFF) | Ministry | Agri-Health Transitional Research Project |
| | | Project to Develop Regulatory Science New Technologies |
| | National Institute of Agrobiological Sciences (NIAS) | National Institute of Agrobiological Sciences (NIAS) Genebank Project |
| Ministry of Economy, Trade and Industry (METI) | Ministry | Program to Formulate Guidelines Designed to Promote Development and Commercialization of Medical Equipment |
| | National Institute of Advanced Industrial Science and Technology (AIST) | Healthcare Support Technologies using Cell-Manipulation and Biomaterial Technologies |
| | | Technologies to Characterize and Analyze the Functions of Biomolecules |
| | | Drug Discovery Support Technologies and Diagnostic Techniques through the Amalgamation of Information Processing and Bioanalysis |
| | | Advanced Measurement Technologies of Human Functions and Behaviors |
| | | Assessment Technique of Health Condition based on Biomedical Information |
| | | Development of Technologies to Restore Health and Achieve Healthy Life |
| | | Development of National Measurement Standards to Support Life Innovation |
| | | Establishment of Safety of Personal Care Robots |
| | | Development of Highly Efficient and Functional Systems Through the Use of IT |
| | New Energy and Industrial Technology Development Organization (NEDO) | Comprehensive R&D of an Early Stage Diagnosis Method and Instruments to Treat Cancer |
| | | Research and Development of Next-generation Regenerative Technology |
| | | Fundamental Technology Development for Drug Discovery Using Epigenetic Genome Modification Mechanisms |
| | | Translational Research Promotion Project |
| | | Fundamental Technology Development for Promoting the Industrial Application of iPS Cells |
| | | Project for Practical Applications of Service Robot |
| Ministry of the Environment (MOE) | National Institute for Environmental Studies (NIES) | Japan Environment and Children's Study (JECS) |